

FIELD SAMPLING PLAN
FOR OMEGA CHEMICAL SUPERFUND SITE OPERABLE UNIT 2
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

MONTEBELLO FOREBAY
LOS ANGELES COUNTY, CALIFORNIA

EPA CONTRACT NO. 68-W-98-225
EPA WORK ASSIGNMENT NO. 175-RICO-09BC
CH2M HILL PROJECT NO. 183122

Prepared for
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Prepared by
CH2M HILL
164 West Hospitality Lane, Suite 2
San Bernardino, California 92408

April 2004

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U.S. ENVIRONMENTAL PROTECTION AGENCY REGION IX

Plan Title: Draft Field Sampling Plan for Omega Chemical Superfund
Site Operable Unit 02 Remedial Investigation/Feasibility
Study Oversight

Site Name: Omega Chemical Superfund Site

Site Location: Whittier

City/State/Zip: Los Angeles County, California

Site EPA ID#: 09BC

Anticipated Sampling Dates: 2004 to 2005

Prepared By: Tom Perina

Date: April 2004

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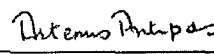
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Acronyms and Abbreviations

AL	action level
ARARs	applicable or relevant and appropriate requirements
ARCH	air rotary/casing hammer (method of well drilling)
B	soil borings
bgs	below ground surface
BOD	biological oxygen demand
°C	degrees Celsius
CDM	Camp Dresser & McKee
CDWR	California Department of Water Resources
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
CLP	contract laboratory program
CPT	Cone Penetrometer Testing
COC	chain-of-custody
COD	chemical oxygen demand
CTR	California Toxics Rule
1,1-DCA	1,1-dichloroethane
1,2-DCA	1,2-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
DHS	Department of Health Services
DO	dissolved oxygen
DQO	data quality objective
EC	electrical conductivity
EPA	Environmental Protection Agency
Freon 11	trichlorofluoromethane
Freon 113	trichlorotrifluoroethane

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ft/ft	feet per foot
FB	field blank
FSP	field sampling plan
GAC	granular activated carbon
gpm	gallons per minute
HCl	hydrochloric acid
HPLC	high pressure liquid chromatography
IDW	investigation-derived waste
L/min	liters per minute
µg/L	micrograms per liter
MCL	maximum contaminant limit
mg/L	milligrams per liter
mL	milliliter
mL/L	milliliters per liter
MS	matrix spike
MSD	matrix spike duplicate
msl	mean sea level
MW	EPA monitoring wells
ND	non-detects
NDMA	n-nitrosodimethylamine
NTU	nephelometric turbidity unit
OPOG	Omega Chemical Site Potentially Responsible Party Organized Group
ORP	oxidation-reduction potential
OU	operable unit
OW	OPOG monitoring wells
PCB	polychlorinated biphenyl
PCE	perchloroethylene (tetrachloroethene)
PHG	public health goals
PID	photoionization detector
PP	push-probe sampling
PRP	potentially responsible party

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PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act of 1978
RFA	request for analyses
RI/FS	remedial investigation/feasibility study
RPM	remedial project manager
RSCC	Region IX Sample Coordination Center
SVOC	semivolatile organic compound
1,1,1-TCA	1,1,1-trichloroethane
1,2,3-TCP	1,2,3-trichloropropane
TCE	trichloroethene
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TPH-d	<i>total petroleum hydrocarbons-diesel</i>
TPH-g	<i>total petroleum hydrocarbons-gasoline</i>
trans-1,2-DCE	trans-1,2-dichloroethene
TSDF	treatment, storage, and disposal facility
TTLC	total threshold limit concentration metals
USA	Underground Service Alert
VOA	volatile organic analysis
VOC	volatile organic compound
Weston	Weston Solutions, Inc.

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SECTION 1

Objectives

This Field Sampling Plan (FSP) has been prepared to support the U.S. Environmental Protection Agency (EPA) in conducting a remedial investigation/feasibility study (RI/FS) for the Omega Chemical Superfund Site Operable Unit 2 (OU-2). Field activities under this investigation will include soil and soil gas sampling, installation and sampling of new groundwater wells, sampling of existing EPA and potentially responsible party (PRP) monitoring wells, and aquifer testing. This FSP was developed in accordance with EPA Region IX, *Guidance for Preparation of a U.S. EPA Region IX, Field Sampling Plan for EPA-Lead Superfund Projects* (EPA, 1993).

1.1 Background

The Omega Chemical Corporation (Omega) is a former refrigerant/solvent recycling operation located in Whittier, California, a community of approximately 85,000 people (Figure 1-1) (all figures located at end of respective section). The facility is located across the street from a residential neighborhood and within 1 mile of several schools, including three elementary schools and two high schools. The facility operated as a Resource Conservation and Recovery Act (RCRA) solvent and refrigerant recycling and treatment facility from approximately 1976 to 1991, handling primarily chlorinated hydrocarbons and chlorofluorocarbons. Drums and bulk loads of waste solvents and chemicals from various industrial activities were processed at Omega to form commercial products. Chemical, thermal, and physical treatment processes were reportedly used to recycle the waste materials. Wastes generated from these treatment and recycling activities included distillation column (still) bottoms, aqueous fractions, and nonrecoverable solvents. Additional data regarding site history and past investigations and remediation activities are discussed in detail in the *Final On-Site Soils RI/FS Work Plan* (Camp Dresser & McKee [CDM], 2003) and the *Omega Chemical Superfund Site; Whittier, California; Phase 2 Groundwater Characterization Study Report* (Weston Solutions, Inc. [Weston], 2002).

Chlorinated hydrocarbons (primarily perchloroethylene [PCE], trichloroethene [TCE], 1,1-dichloroethene [1,1-DCE], cis-1,2-dichloroethene [cis-1,2-DCE], and chloroform) and Freons (trichlorofluoromethane [Freon 11] and trichlorotrifluoroethane [Freon 113]) were identified as the primary chemicals of concern in soil and groundwater directly beneath the site. Elevated total chromium also was reported in groundwater beneath the Omega site. Perchlorate contamination is suspected. Other contaminants of concern (detected or suspected at the site) include cyanides, n-nitrosodimethylamine (NDMA), pesticides and polychlorinated biphenyls [PCBs], dissolved metals, and 1,4-dioxane. Elevated concentrations of chemicals of concern were also reported in groundwater west and southwest of the Omega facility, suggesting that a downgradient migration of the contaminant plume from the site has occurred.

EPA has divided the Omega Chemical Superfund Site into two Operable Units: OU-1 and OU-2. OU-1 includes the former Omega Chemical Facility property and extends a short

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distance west-southwest approximately to Putnam Street (Weston, 2003). OU-2 surrounds the Omega Chemical Facility and extends offsite at least 2.2 miles to the southwest. The exact geographical extent of OU-1 and OU-2 has not been defined. OU-1 encompasses what is considered a "source area" at the former Omega Chemical Facility property. OU-2 includes contamination in groundwater that has originated from the former Omega Chemical Facility property and potentially also from other sites. The potential other source areas are also part of OU-2. One of the goals of EPA's investigation is to find the extent of OU-2.

1.2 Objectives

The scope of this FSP is to perform fieldwork associated with the OU-2 RI/FS on behalf of EPA. As stated in the EPA Work Plan (CH2M HILL, 2003), the overall objective of the field investigation is to collect data needed to fulfill the following Work Plan goals:

- Characterize the vertical and lateral extent of contamination and the subsurface hydrogeology within and at the leading edge (south and southwestern edge) of the OU-2 contaminant plume. Reports on remedial activities for contaminated sites other than the Omega facility will be reviewed and the information evaluated. Approximately 11 monitoring wells or well clusters (one to three wells at each location) and one extraction well will be installed as part of this investigation.
- Determine the hydraulic properties of the shallow contaminated aquifer at OU-2 by conducting a series of aquifer tests or slug tests at new and existing EPA and OPOG monitoring wells (OPOG is the *Omega Chemical Site Potentially Responsible Party Organized Group*).
- Confirm the nature and extent of groundwater contamination and monitor plume migration by conducting future quarterly and semiannual groundwater sampling and analysis of all new and existing EPA and OPOG groundwater monitoring wells for a period of 2 years.
- Obtain the information needed to evaluate contaminant fate and transport in the subsurface, to evaluate discharge options for treated groundwater, and to complete a baseline human health and ecological risk assessment.
- Establish a permanent groundwater monitoring network by installing new monitoring wells.

Additional investigation of potential source areas within OU-2, other than the Omega Chemical Facility, will be conducted, as necessary, when information on these areas becomes available. EPA and their consultants are currently performing a record search to identify and collect information on potential source areas within OU-2. Depending on the record search results, field investigation of some of the potential source areas may be warranted. This investigation will minimally include soil gas sampling, surface and subsurface soil sampling, groundwater monitoring well installations, and groundwater sampling. This FSP describes the field activities associated with groundwater sampling, groundwater monitoring well installation, and testing of wells for aquifer hydraulic parameters. Surface and subsurface soil sampling and soil gas sampling, if required, will be described in a subsequent FSP Addendum.

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Figure
1-1 Site Location Map

Site Background

2.1 Location and Topography

The Omega Chemical Facility is located at 12504 and 12512 East Whittier Boulevard in Whittier, California (Figure 1-1). The City of Santa Fe Springs is located southwest of the site. The community of Los Nietos is included within the City of Santa Fe Springs. Unincorporated County of Los Angeles land is located northwest of the site.

The Omega Chemical Facility is located along the base of the La Habra piedmont slope descending from the southwestern flank of the Puente Hills, at an elevation of approximately 220 feet above mean sea level (msl) (Weston, 2003). The piedmont slope descends toward the southwest at a slope of approximately 2.5 percent to a point approximately 2,800 feet southwest of the Omega Chemical Facility. At this point, the ground surface flattens into a broad basin or plain, at an elevation of approximately 150 to 155 feet msl. In the southwestern part of the study area, the ground surface ascends a low rise at the northwest end of the Santa Fe Springs plain, at an approximate elevation of 160 feet msl (Weston, 2003). The site and surrounding areas are completely developed. The Sorenson Avenue drain is a small channelized drainage that flows southeast from the intersection of Dice Road and Slauson Avenue and becomes La Canada Verde Creek to the south of the OU-2 study area (Weston, 2003).

2.2 EPA Activities in the OU-2 Area

Data obtained in 1988 from site assessment activities, including groundwater and soil sampling conducted by the site owner/operator, Dennis O'Meara, and data from a preliminary assessment conducted by EPA in January 1995 (EPA, 1995a), indicated the presence of hazardous substances in subsurface soil and groundwater at the site, including methylene chloride, PCE, and TCE. The presence of these substances and deteriorated underground storage tanks at Omega led EPA to determine that an imminent and substantial endangerment requiring a removal action existed at Omega.

On May 3, 1995, EPA issued an Unilateral Administrative Order (EPA, 1995b) authorizing a Removal Action involving the following response actions:

- Securing the site
- Sampling and categorizing hazardous materials
- Removing hazardous substances and grossly contaminated equipment, structures, and debris
- Sampling surface and subsurface soils and groundwater to determine the nature and extent of contamination
- Disposing, stabilizing or treating grossly contaminated soils

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- Grading, capping, and fencing contaminated soil areas

As part of the OU-1 effort, EPA entered into a Partial Consent Decree with the PRPs who had agreed to complete work at the site (OPOG). This Partial Consent Decree was entered into the District Court on February 23, 2001. OPOG agreed to perform an RI/FS, conduct a Non-Time Critical Removal Action, perform a risk assessment, and install groundwater monitoring wells at OU-1, also referred to as the Phase 1A area.

As part of the OU-2 effort, EPA issued an order to another group of PRPs to complete work at OU-2 and initiated settlement negotiations with the remaining PRPs. The resolutions of these actions are pending. The PRPs may perform a portion of the field activities described in this FSP, namely the well installation. In such case, CH2M HILL will provide oversight of the PRPs' activities. In the meantime, EPA authorized its consultant, CH2M HILL, to initiate the RI/FS at OU-2.

EPA is currently conducting the OU-2 RI/FS, and CH2M HILL is providing consulting services (including field activities) on behalf of EPA.

2.3 Hydrogeology

This section summarizes the site regional hydrogeological setting and site-specific hydrogeologic conditions.

2.3.1 Regional Hydrogeology

The following information on regional hydrogeological setting is largely based on the California Department of Water Resources (CDWR) Bulletin 104 (1961).

The site is located in the Central Basin of the Coastal Plain of Los Angeles County. The Coastal Plain is bounded on the west and south by the Pacific Ocean and by mountains on the north, east, and southeast. The Coastal Plain is underlain by an extensive groundwater basin in Los Angeles and Orange Counties.

Water-bearing sediments identified in the Whittier area extend to an approximate depth of at least 1,000 feet below ground surface (bgs). The identified geologic units consist of Recent alluvium, the upper Pleistocene Lakewood Formation and the lower Pleistocene San Pedro Formation. Figure 2-1 shows a generalized stratigraphic column of water-bearing sediments in the Whittier area. The Pliocene and Miocene marine sediments below the San Pedro Formation generally contain saline water in the Whittier area, although locally can contain fresh water. These units are considered non-water-bearing where exposed in the Puente Hills and include the Pliocene Pico and Repetto Formations and the Upper Miocene Puente Formation.

The major geologic structures in the area include a homocline that underlies the La Habra piedmont slope, the northwest-trending La Habra syncline underlying the alluvial basin, and the west-northwest trending Santa Fe Springs anticline situated below the slightly uplifted Santa Fe Springs plain. The La Habra syncline affects the San Pedro Formation and, to a lesser extent, the Lakewood Formation, and has a surface expression as the axis of the basin. The Santa Fe Springs anticline folds both the San Pedro and Lakewood Formations;

shallow aquifers thin across the crest of the anticline. The west-northwest trending Whittier fault is located northeast of the site in the Puente Hills (CDWR, 1961).

As reported by CDWR (1961), the uppermost unit in the vicinity of the Omega site consists of the "Bellflower Aquiclude." The Bellflower Aquiclude comprises all the fine-grained sediments that extend from the ground surface down to the first aquifer. The Bellflower Aquiclude consists primarily of clay and sandy clay to silt, and ranges from 20 to more than 40 feet in thickness in this area. CDWR (1961) considers the Bellflower Aquiclude to be present in both the recent alluvium and the upper part of the Lakewood Formation. In the Whittier area, the Bellflower Aquiclude is considered to be entirely within the Lakewood Formation. Water-bearing zones locally occurring within the Bellflower Aquiclude are referred to collectively and informally as the Semi-perched Aquifer.

The Lakewood Formation consists of non-marine deposits of Late Pleistocene age and attains a maximum thickness of 70 feet. The Gage Aquifer is the major water-bearing member and comprises the basal lithologic unit of the Lakewood Formation. It consists of about 30 feet of sand with some interbedded clay. Based on previous investigations at the Omega site, the Gage Aquifer appears to be absent beneath the site proper. A sand interval found in exploratory borings a short distance southwest of the site is believed to correlate with the Gage Aquifer (England and Hargis, 1996). The Gage Aquifer is interpreted by CDWR (1961) to extend eastward approximately 2.5 miles south of the site. However, exploratory borings suggest the Gage is present west of the Omega site, but pinches out or disappears toward the east. The Gage Aquifer does not appear to be an important source of drinking water in the Whittier area, based on elevated total dissolved solids (TDS) concentrations observed during sampling, and none of the local water supply wells produce water from this aquifer.

Underlying the Lakewood Formation are primarily marine sand and gravels with interbedded clay, assigned to the San Pedro Formation. The San Pedro Formation reaches a maximum thickness of 850 feet and extends to a depth of about 920 feet. The San Pedro Formation unconformably underlies the Lakewood Formation. The San Pedro Formation has been subdivided into five named aquifers separated by clay members. A fine-grained layer is also typically present at the top of the sequence, although in localized areas, the uppermost San Pedro Formation aquifer may be merged with the overlying aquifer, and one or more of the five aquifers may also be merged (CDWR, 1961). This suggests that the Gage sand unit could directly overlie, and be in hydraulic connection with, San Pedro Formation aquifers in the vicinity of the Omega site. Subsurface explorations conducted near the site to date, however, have identified clays underlying the suspected Gage-equivalent sand unit.

The five aquifers defined within the San Pedro Formation include, from top to bottom, the Hollydale, Jefferson, Lynwood, Silverado, and Sunnyside. The upper two aquifers are less extensive and appear to be absent in the immediate vicinity of the Omega site.

The San Pedro aquifers consist of varying amounts of sand and gravel with some interbedded clay. The thickness of the aquifers increases with depth. The shallow Hollydale Aquifer ranges from 10 to 25 feet, whereas the deepest Sunnyside Aquifer ranges from 200 to 300 feet. The base of the Sunnyside Aquifer reaches a maximum depth of about 1,000 feet bgs (CDWR, 1961). The San Pedro Formation aquifers are the primary source of water for the production wells in the area.

The Pliocene and Miocene sediments below the San Pedro Formation generally contain saline water in the area, but locally contain freshwater (CDWR, 1961).

Based on a records search by England-Hargis (1996), there are six water supply wells within 1.5 miles of the site. The nearest well, 02S/11W30-R3, also known as Santa Fe Springs Well No. 1 (SFS#1), is located 1.3 miles to the west-southwest of the former Omega Facility, at the Santa Fe Springs Fire Station on Dice Road near Burke Street. The well is screened from 200 to 288 feet bgs and 300 to 900 feet bgs. Aquifers that are tapped by SFS#1 are believed to include the Silverado and Sunnyside Aquifers, which occur within the lower part of the Lower Pleistocene San Pedro Formation. In several years of monitoring SFS#1, low concentrations of chlorinated hydrocarbons (including TCE, chloroform, and PCE) have occasionally been detected. Most recently (in February 2003), only TCE at a concentration of 0.64 microgram per liter ($\mu\text{g/L}$) was reported above the detection limit. Hexavalent chromium was reported at a concentration of 2.6 $\mu\text{g/L}$. The depth interval(s) from which the contamination is entering the well has not been established. The production rate of SFS#1 ranges up to approximately 1,250 gallons per minute (gpm) (England and Hargis, 1996). It is not established what effect well SFS#1 has on local groundwater flow direction and contaminant migration; shallow groundwater in the vicinity of the well appears to flow toward the south, unaffected by pumping from SFS#1 (Weston, 2003).

The Los Nietos water supply well (02S/11W30-Q5) is located about 1.5 miles southwest of the site (about 1,500 feet west-northwest of SFS#1). This well is screened from 152 to 370 feet bgs. PCE and TCE were detected at unknown concentrations in 1986-90 (Weston, 2003). The well locations are shown on Figure 3-1, in Section 3.

The remaining wells (2S/11W-29E5, 2s/11W-32G3, 2S/11W-33M1, and 2S/11W-32J4) are no longer operating, are used for irrigation, no water-quality data were available, or their exact locations are unknown (Weston, 2003).

2.3.2 Site Hydrogeology

The hydrogeology of the Omega site has been explored with borings and Cone Penetrometer Testing (CPT). The former Omega Chemical site is underlain by relatively low permeability silty and clayey soils to a depth of about 120 feet bgs. A sand unit, which may correlate with the Gage Aquifer, has been encountered approximately 600 feet southwest of the site beneath Putnam Street. Groundwater at OU-1 generally occurs at a depth of approximately 70 feet bgs. The depth to groundwater ranges between 40 and 70 feet over OU-2. Locally, groundwater flow appears to be generally to the southwest. Camp Dresser and McKee (CDM, 1999) reported a local direction of groundwater flow toward the southwest with a hydraulic gradient of 0.009 foot per foot (ft/ft). TDS concentrations of greater than 3,000 milligrams per liter (mg/L) were reported in shallowest groundwater samples collected by CDM (1999).

The hydraulic conductivity of the upper silty unit was estimated from step-drawdown tests conducted in Monitoring Well OW2 and a slug test at Monitoring Well OW1. The hydraulic conductivity in this area was found to range from 0.8 to 1.6 feet per day (CDM, 2003). The hydraulic conductivity of the more permeable units southwest of Omega is not known.

2.4 Nature and Extent of Contamination

2.4.1 Nature of Contamination

Groundwater at the Omega site has been impacted primarily by chlorinated hydrocarbons and Freon compounds (i.e., volatile organic compounds [VOCs]). The following summary is based on the results of the Phase 2 Groundwater Characterization Study conducted by Weston Solutions, Inc. (2003).

The five primary chlorinated compounds detected in groundwater are:

- Perchloroethene/Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- 1,1-dichloroethene (1,1-DCE)
- cis-1,2-dichloroethene (cis-1,2-DCE)
- Chloroform

These are the most widespread VOCs detected in groundwater in the vicinity of the Omega site.

Eight other VOCs were locally detected in groundwater in lower concentrations. These compounds include:

- 1,2-dichloroethane (1,2-DCA)
- 1,1-dichloroethane (1,1-DCA)
- 1,1,1-trichloroethane (1,1,1-TCA)
- trans-1,2-dichloroethene (trans-1,2-DCE)
- 1,2-dichloropropane
- Vinyl chloride
- Methylene chloride
- Carbon tetrachloride

Freon compounds reportedly detected at the site include:

- Trichlorofluoromethane (Freon 11)
- 1,1,2-trichloro-1,2,2-trifluoroethane, commonly referred to as trichlorotrifluoroethane (Freon 113)

As part of Weston's investigation, groundwater samples from monitoring wells were also analyzed for metals, as well as some indicators of the potential for occurrence of natural attenuation processes including total organic carbon (TOC), total Kjeldahl nitrogen (TKN), sulfate, sulfide, and methane/ethane/ethene. Of these analytes, total chromium was the most significant with respect to groundwater impacts originating from the Omega site versus other potential contamination sources. At some monitoring wells, chromium concentrations approached or exceeded the maximum contaminant level (MCL) of 50 µg/L for drinking water (Weston, 2003).

CDM (1999, 2003b) also reported low detections of aromatic hydrocarbons (toluene, acetone, xylenes, ethylbenzene, and benzene) in samples from shallow wells at the former Omega Chemical Facility. However, toluene and acetone concentrations of up to 900 µg/L and

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6,300 µg/L, respectively, have been detected in samples from Well OW8 located downgradient of the Omega site. These compounds appear to be from a different downgradient source (CDM, 2003b).

2.4.2 Extent of Contamination

Figures 2-2 through 2-5 present chemical distribution maps for PCE, TCE, Freon 11, and Freon 113 in groundwater, respectively. Maps for these particular analytes are presented because of their widespread distribution and reportedly higher concentrations offsite of Omega. The maps contain data from Phase 1 and Phase 2 investigations conducted by Weston Solutions, Inc. The data points include results from push-probe sampling (PP), soil borings (B), EPA monitoring wells (MW), and OPOG monitoring wells (OW). The contours are presented as drawn by Weston (2003) without modification.

As shown on Figure 2-2, the PCE plume extends at least 2.2 miles downgradient west-southwest of the Omega site, with a width approaching 3/4 mile. The maximum PCE concentration observed at the site was in groundwater from soil boring B109 (53,000 µg/L), which is located less than 500 feet west of Omega. High PCE concentrations were also reported at other borings in the immediate area (B108 and B110). The PCE concentrations at B108 and B110 were 5,100 µg/L and 8,000 µg/L, respectively. Concentrations above 1,000 mg/L comprise about 5 percent of the area of the PCE plume, occurring primarily within approximately 2/3-mile downgradient of the Omega site. Most of the PCE plume is characterized by concentrations in the range of 10 to 100 µg/L. An isolated area of relatively high concentrations of PCE was reported at PP058 and PP066 (3,300 µg/L and 850 µg/L, respectively), indicating the likely presence of a separate source area in this region. Because the majority of the monitoring points that have been used to define the VOC plumes are based on in situ groundwater samples from CPT soundings, which sample only a very small depth interval, it is possible that some of the lateral variation in concentrations is a result of the limitations of this sampling technique.

The TCE plume (Figure 2-3) is similar in extent to the PCE plume, but is narrower and exhibits lower concentrations overall. The majority of the TCE plume comprises concentrations between 10 and 100 µg/L, but concentrations exceeding 100 µg/L appear to be more continuous (if less extensive) than for the PCE plume. The highest concentration parts of the TCE plume (greater than 1,000 µg/L) occur in apparently unconnected zones near the Omega site. The narrower and smaller occurrence is nearly coincident with the estimated extent of 10,000 µg/L PCE concentrations immediately downgradient from the Omega site. The other area of 1,000 µg/L TCE begins with a concentration of 7,000 µg/L at its northeastern end (B103) and continues west-southwest for approximately 3,000 feet. Unlike PCE, elevated TCE concentrations occur northwest of the Omega site in concentrations ranging from approximately 200 to 960 µg/L.

The Freon 11 plume (Figure 2-4) and Freon 113 plume (Figure 2-5) are approximately one-half to two-thirds the width of the PCE and TCE plumes; however, the downgradient extent is approximately 90 percent that of the TCE and PCE plumes. The plumes are well defined by groundwater samples with detected concentrations less than 2 µg/L to the north, west, and south sides. Aside from the smaller downgradient extent and lower concentrations of the Freons (800 µg/L maximum for Freon 11 and 2,400 µg/L for Freon 113),

the distribution of the Freons is similar to that of PCE and TCE. The southwestern end of the Freon 113 plume encompasses the isolated area of elevated (greater than 1,000 µg/L) PCE concentrations some 8,000 feet from the Omega site. The Freon 11 plume also extends to this area. The Freon concentration contours are drawn (Weston, 2003) as discontinuous (Figure 2-5); however, the data may also be interpreted as one continuous plume similar to the Freon 113 plume.

Data indicative of the vertical distribution of contamination include groundwater samples from co-located monitoring wells screened at different depths and co-located direct-push samples collected at different depths. In most cases, contaminant concentrations were much lower at deeper intervals, particularly where intervening fine-grained units restricted downward migration (Weston, 2003). Almost all groundwater samples were collected from depths less than 100 feet bgs, or about 30 to 60 feet below the water table. It is anticipated that within the known extent of the VOC plume, significant contaminant concentrations in groundwater are limited to the shallow zone of approximately 30 to 60 feet below the water table. Locally, however, the contamination may be present in deeper, highly permeable units that serve as preferential groundwater flow pathways. Also, further downgradient the contamination is expected to migrate deeper as a result of areal recharge to the aquifer.

2.4.3 Contaminant Migration

The contaminant migration rate was considered for the proposed well placement at the downgradient (leading) edge of the plume. The site history and estimated extent of the contamination in groundwater provide an indication of the plume migration rate. The Omega site started operations in 1976. The contamination has apparently migrated almost 13,000 feet southwest from the Omega site over 26 years (between 1976 and 2002 field investigations; Weston, 2003). Assuming that a contaminant release occurred in the first year of operation, the average contaminant migration rate is 500 feet per year. This apparent migration rate estimate assumes the longest known timeframe over which the contamination could travel in groundwater from the Omega site. However, it is also possible that the contamination found in portions of the downgradient area of the plume originated entirely from sources other than the Omega site. In such a case, the contaminant migration could be slower.

The estimated rate of 500 feet per year can be considered the upper limit. Considering a groundwater gradient across the entire OU-2 (0.0032 ft/ft) and an effective porosity of 14.3 percent (Weston, 2003), this migration rate would correspond to an "effective" or average hydraulic conductivity at OU-2 of 60 feet per day. Such a hydraulic conductivity value can be expected for shallow unconsolidated sands. Therefore, the migration rate of 500 feet per year may be a realistic migration rate of contamination from the Omega site.

The elevated VOC concentrations in the general vicinity of the intersection of Dice Road and Los Nietos Road (Figures 2-2 to 2-5) may have originated from sources other than the Omega site. Groundwater contours for February-March 2003 (Figure 2-6) and for May-June 2003 (Figure 2-7) indicate that this area is downgradient of several industrial facilities with known groundwater contamination (such as McKesson Corporation and Angeles Chemical). Production well SFS#1 is located north of the anticipated flow path from the Omega site, indicating that the well may have been impacted by contamination from other sites.

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Figure
2-1 Generalized Stratigraphic Column

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Figure
2-2 PCE Concentrations in Groundwater

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Figure
2-3 TCE Concentrations in Groundwater

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Figure 2-3 continued

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Figure
2-4 Freon 11 Concentrations in Groundwater

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Figure
2-5 Freon 113 Concentrations in Groundwater

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2-2 **Figure 2-6**
February-March 2003 Groundwater Contours

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Figure
2-7 May-June 2003 Groundwater Contours

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SECTION 3

Rationale for Sample Locations, Number of Samples, and Laboratory Analyses

This section presents the overall rationale for the sampling and analysis associated with this RI/FS. A description of the sample locations, number of samples, and laboratory analyses to be performed on those samples also is provided. The number and location of samples collected may vary depending on changes in the scope of work.

As discussed in Section 1, and in the data quality objectives (DQOs) included in the accompanying Quality Assurance Project Plan (QAPP), the sampling activities will address the following:

- Installation of additional groundwater monitoring wells to (1) further assess the nature and extent of groundwater contamination; (2) provide additional information regarding the subsurface geology and contaminant transport; (3) provide locations for measurement of water levels to assess groundwater flow directions; and (4) provide permanent monitoring locations that can be used to assess changes in contaminant concentration over time.
- Aquifer testing and slug testing of new wells to estimate hydraulic properties of the shallow zone aquifer beneath and downgradient of the site.
- Sampling of investigation-derived waste (IDW), including drill cuttings, well development water, well purge water, and potentially drilling mud, to determine the appropriate disposal option.
- Groundwater sampling to assist in identifying additional potential sources of groundwater contamination.
- Baseline groundwater sampling to determine the presence of emergent groundwater contaminants (1,4-dioxane, perchlorate, NDMA, hexavalent chromium, and 1,2,3-trichloropropane [1,2,3-TCP]).
- Groundwater sampling and analysis of parameters for evaluation of groundwater treatment options and options for discharge of treated groundwater.
- Ongoing groundwater sampling and water level monitoring to identify changes in contaminant extent and concentration and groundwater flow direction.

3.1 Well Installation

During the remedial investigation, 11 monitoring wells or clusters and one extraction well will be installed to further characterize the nature and extent of contamination and to characterize the site hydrogeology. The new groundwater wells will be installed to:

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- Further characterize the vertical and lateral extent of contaminant distribution in groundwater within the OU-2 study area, and better define the contaminant distribution within the plume.
- Investigate the potential presence of emerging contaminants.
- Further define aquifer lithology and estimate aquifer hydraulic properties from aquifer tests and slug tests.
- Better define groundwater flow direction in the downgradient portion of the plume.
- Assess vertical flow gradients and provide permanent monitoring points for measuring groundwater elevations.
- Provide permanent monitoring points for tracking contamination in the downgradient plume area and contaminant distribution within the plume. Groundwater monitoring wells will be sampled quarterly for 2 years to evaluate long-term concentration trends and to generate sufficient data to accurately assess representative concentrations.

3.1.1 Well Location Rationale

Eleven monitoring wells or well clusters (PMW12 to PMW22) and one extraction well (PEW1) are proposed for construction in the OU-2 study area. The rationale for the proposed well placement and their location is summarized in Table 3-1. Figure 3-1 shows the locations of the proposed wells and screen depths, as well as the locations of existing EPA and OPOG monitoring wells. The proposed wells are also shown on the PCE, TCE, Freon 11, and Freon 113 plume maps (Figures 2-2 through 2-5). The proposed well names start with "PMW" and continue with a sequential number (e.g., PMW15). They are numbered sequentially from east to west, not in the order in which they will be installed (the installation of some of the wells will be postponed, as discussed below). Once installed, the wells will be numbered in a sequence with the existing wells in the order of installation (i.e., starting with MW12).

A combination of single-screen monitoring wells and well clusters, is proposed. Well clusters will allow monitoring of heads and contaminant concentrations at different depth zones. In the downgradient area of the plume, well clusters are also more likely to intercept contamination that may have spread over a greater extent and depth in the aquifer compared to locations closer to the source. The well clusters will be installed as multi-completion wells within one or two borings. Two three-well clusters are proposed.

Single-screen wells will be installed at the remaining locations. The well screen intervals will be selected based on the results of discrete-depth groundwater sampling during drilling; the depth interval with the highest contaminant concentration will be screened. If discrete-depth sampling results indicate that groundwater contamination extends over more than one permeable unit, a well cluster will be installed at that location instead of a single well.

As shown on Figure 2-2, proposed monitoring well clusters PMW17 and PMW20 are situated along the suspected axis of the PCE contaminant plume in the downgradient area. Well PMW17 is proposed downgradient of a high-concentration area exceeding 1,000 µg/L that is located approximately 8,000 feet downgradient of the Omega site and approximately two-thirds of the distance to the leading edge of the plume. A cluster of two to three wells is

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proposed here instead of a single well to allow monitoring of heads (to assess vertical flow gradients) and contaminant concentrations in groundwater at different depths. Well PMW20 is situated close to the anticipated leading edge of the plume. A cluster of wells, instead of a single well, is proposed at this location because the depth interval of the contaminated aquifer is expected to increase with distance from the source area(s). A well cluster will allow for monitoring of contaminant concentrations and heads at different depths. A well cluster is also more likely to intercept contamination that may migrate to this location at a later time than a single well.

TABLE 3-1

Location and Rationale for Groundwater Monitoring Wells

Well Name	Location	Rationale
PEW-1	About 30 feet from MW08 well cluster	Pumping well for an aquifer test within an apparent zone of preferential contaminant migration. Screened approximately between 60 and 80 feet bgs to target the same depth zone as MW08B.
PMW12	On Baldwin St., 500 feet west of Whittier Blvd.	Provide information on contaminant distribution in an area that may have been impacted by a source other than Omega.
PMW13	About 500 feet east-southeast from the intersection of Putnam St. and Pacific St.	Provide information on contaminant distribution that likely originated from a source other than Omega.
PMW14	On Washington Blvd., about 250 feet west of intersection with Lambert Rd.	Provide data in a high-concentration area of the plume to verify the plume continuity and vertical contaminant distribution, and to characterize the lithology down-gradient of the Omega site.
PMW15	Southwest of the south end of Calopar Ave.	Verify the plume continuity in an area that contains elevated VOC concentrations downgradient of the Omega site.
PMW16	Between Dice Rd. and Sorensen Ave., about 2,000 feet south of Burke St.	Characterize the distribution of contamination within the plume. Well is located upgradient of a potential separate VOC source other than Omega.
PMW17	At the intersection of Pike Dr. and Pacific St.	3-well cluster to characterize and monitor vertical extent of contamination at a location downgradient of a high concentration area away from the Omega site, and provide lithologic and head data.
PMW18	At the intersection of Santa Fe Springs Rd. and Los Nietos Rd.	Characterize leading edge of the contaminant plume.
PMW19	At intersection of Bell Ranch Rd. and Flagon St.	Characterize leading edge of the contaminant plume.
PMW20	On Geary Ave., 500 feet south of intersection with Matern St.	Three well cluster to characterize vertical extent of contamination, and provide lithologic and head data.
PMW21	On Hamder St., 250 feet east of Pioneer Blvd.	Characterize leading edge of the contaminant plume.
PMW22	At intersection of Arlee Ave. and Fredson St., 1,500 feet west of intersection of Norwalk Blvd. and Pike Dr.	Characterize leading edge of the contaminant plume.
PMW23, PMW24, PMW25	Downgradient of PMW18, PMW19, PMW20, PMW21, PMW22	Characterize leading edge of the contaminant plume if necessary (e.g., if contamination above MCLs is detected in samples from wells PMW18, PMW19, PMW20, PMW21, PMW22).

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Proposed monitoring wells PMW18, PMW19, PMW21, and PMW22 are situated near the suspected leading edge of the contaminant plume and will assist in characterizing the lateral extent of contamination downgradient of the Omega Site. Installation of these wells will also provide additional information on groundwater elevations and aquifer lithology. These wells are proposed in areas of expected low concentrations. The proposed well locations may be modified based on the results of the investigation (cluster wells PMW17 and PMW20 will be installed before the leading-edge wells). The downgradient extent of the contamination as shown on Figures 2-2 to 2-5 is unknown because no data are available from the downgradient area. Preferably, the new downgradient wells would be installed in a zone where contaminant concentrations range between non-detects (NDs) and MCLs to characterize the plume leading edge. If contaminant concentrations detected in groundwater samples from wells PMW18, PMW19, PMW21, and PMW22 exceed MCLs, approximately three additional wells will need to be installed farther downgradient.

Well PMW16 is situated along the axis of the plume, upgradient of the greater than 1,000 µg/L hot spot located in the vicinity of Los Nietos Road and Pacific Street, where potential sources of contamination other than the Omega site may be present. This well will be installed to characterize the distribution of contamination within the plume. There is an apparent low-concentration zone at this location (Figure 2-2 PCE), and a high-concentration zone just downgradient, as characterized by a former direct-push investigation. This well will verify the continuity of the plume. The installation of this well will be postponed until after an investigation of the source areas.

Well PMW15 is situated in an apparent high-concentration area approximately 3,000 feet downgradient of the Omega site and will verify the plume continuity. The installation of this well will be postponed until after an investigation of the source areas.

Well PMW14 is proposed in a high-concentration area of the plume, approximately 1,700 feet downgradient of the Omega site, to verify the plume continuity, vertical contaminant distribution, and to characterize the lithology downgradient of the Omega site.

Well PMW12 is proposed approximately 1,100 feet north-northwest of the Omega site in an area of contamination that likely originated from another source. The installation of this well will be postponed until after an investigation of the source areas.

Well PMW13 is proposed approximately 800 feet west-northwest of the Omega site in an area of contamination that may have originated from the Omega site and/or another source. This well will provide information on the aquifer lithology as well as contaminant distribution. The installation of this well will be postponed until after an investigation of the source areas. The contaminant concentration distribution in this area is uncertain; it is largely known from direct-push sampling only. Another well may need to be installed in this area.

Extraction well PEW-1 is proposed to be constructed just south of the existing MW8 well cluster. The extraction well will serve as a pumping well for an aquifer test that will be conducted to estimate aquifer hydraulic properties in this area. This location was selected because it is downgradient of a zone of high contaminant concentrations and is interpreted to be within a highly permeable, laterally extensive zone that provides a preferential contaminant transport pathway from the Omega site. The contaminant concentrations detected in samples from the MW8 well cluster decreased with depth (PCE and TCE

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concentrations of 580 and 120 $\mu\text{g/L}$ in the top screen interval MW08A decreased to 14 and 3 $\mu\text{g/L}$ in MW08B, respectively), indicating that the top screen interval intercepts the main contaminant transport pathway (Weston, 2003). The test will assess the hydraulic communication between the contaminated shallow and relatively clean deeper aquifer zones and will provide estimates of hydraulic properties of the shallow zone aquifer. The deeper screens of Well MW08 are believed to have intercepted regional aquifers (starting with Gage and Hollydale Aquifers from the top) that can potentially become major contaminant transport pathways (Weston, 2003). Pumping from the less contaminated zone will also allow onsite treatment of the extracted groundwater.

The new wells will be installed in two phases. Wells PMW14, PMW17, PMW18, PMW19, PMW20, PMW21, and PMW22 will be installed first to characterize the extent of the contamination, aquifer lithology, and groundwater flow patterns. The installation of wells PMW12, PMW13, PMW15, and PMW16 will be postponed to consider the results of the first phase and also the results of the investigation of the potential source areas other than the former Omega Chemical Corporation site. The proposed locations for the second-phase wells are tentative and will likely be revised based on the new information. Additional wells for characterizing the plume leading edge will be installed during the second phase of drilling, if necessary.

3.1.2 Depth-Discrete Groundwater Samples

Discrete-depth, screening-level groundwater samples will be collected from the boreholes for the monitoring wells in order to select a screen-depth interval within the contaminated zone. The samples will be taken through the drive-casing using a disposable bailer. The first sample will be taken immediately below the water table.

If a thick coarse-grained (sandy) aquifer unit is encountered, the following samples will be collected every 10 feet for a total of five samples. If alternating layers of saturated coarse and fine-grained (silts and clays) sediments are intercepted by the borehole, groundwater samples will be taken from the coarse-grained units. The total number of samples taken may be adjusted according to encountered lithologic conditions and laboratory results. If contamination above MCL is detected in the lowest sample, drilling will continue to a greater depth and additional samples will be taken. If the contaminated zone with concentrations above MCL spans more than 30 feet within one permeable unit, the length of the well screen will be increased (in 5-foot increments, based on the thickness of the contaminated zone) from the proposed 10 feet. If contamination above MCLs is found in two or more permeable zones separated by low-permeability units, a multiple-completion well or a well cluster will be installed.

A 24-hour or shorter turnaround time will be required for the samples to allow for timely decisions regarding well construction. An onsite, mobile laboratory, such as EPA's Field Analytical Support Program Laboratory, will be required to accommodate the short turnaround time and to handle potential additional samples. It is anticipated that the borehole for each well will be drilled in 1 to 2 days and the analytical results will be needed the following day. The drill rig will remain at the site until the analytical results are available for the decision on the screen-depth intervals or to continue drilling to a greater depth. The borings will be drilled and wells installed sequentially.

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The estimated total number of the discrete samples, without quality control (QC) samples, is 55 samples (5 samples per each borehole).

Field blank samples will be collected to check for possible cross-contamination of groundwater samples from the point of sample collection to analysis of the samples by the laboratory. The number of equipment blanks will be 10 percent of the number of primary samples.

One laboratory QC matrix spike/matrix spike duplicate (MS/MSD) sample will be identified for every 20 primary samples collected. A double volume of sample is collected for each MS/MSD.

3.2 Groundwater Monitoring

All site wells will initially be sampled quarterly to characterize the spatial distribution and temporal trends in water quality. OPOG samples OU-1 wells semiannually. CH2M HILL will sample EPA's wells quarterly and OPOG's wells semiannually.

3.2.1 Sampling Rationale

Analysis of VOCs with low-detection limits will be used to assess the magnitude of groundwater contamination in the new monitoring wells and to determine whether any of the VOCs detected exceed regulatory limits. The rationale for the VOC analyses is that VOCs are the most prevalent contaminants known to have originated from the Omega site. Sampling for VOCs will be included in all sampling events. Sampling for metals, semi-volatile organic compounds (SVOCs), NDMA, perchlorate, 1,4-dioxane, 1,2,3-TCP, and hexavalent chromium will be conducted to evaluate exceedances of regulatory limits and to assess the need for continued monitoring or future treatment for these analytes. The rationale for these analyses is that many of the compounds have state or federal MCLs, California action levels, or other regulatory limits, and have been detected in areas of OU-2 where VOCs are present. They also require significantly different treatment methods for removal from groundwater compared to VOCs. Remedial action at OU-2 will have to address these compounds in addition to VOCs.

The analysis for emergent chemicals (NDMA, perchlorate, 1,4-dioxane, 1,2,3-TCP, and hexavalent chromium) will be conducted for two consecutive sampling events. Chemicals that are not detected during the two events will not be subsequently analyzed for.

In addition, two rounds of groundwater samples will be analyzed for major ions (calcium, magnesium, potassium, sodium, bicarbonate, chloride, and sulfate), total phosphorus, nitrate and nitrite as nitrogen, ammonia, cyanide, TDS, biological oxygen demand (BOD), chemical oxygen demand (COD), TOC, alkalinity, and pH to evaluate treatment design issues such as granular activated carbon (GAC) usage, mineral precipitation, and potential clogging or bio-fouling problems within a treatment system. All of the preceding sample analyses will be also used to evaluate the treatment discharge options.

3.2.2 Assessment of Regulatory Requirements

The applicable or relevant and appropriate requirements (ARARs) for waters in the State of California have been summarized by California EPA, Regional Water Quality Control Board, Central Valley Region in a compilation of water quality goals published in

August 2003 (Cal-EPA, 2003), and subsequent changes in MCLs, Action Levels, and the Department of Health Services (DHS) list of unregulated chemicals required to be monitored. The ARARs relevant to the development of this FSP have been summarized in Table A-1 (Appendix A). Table A-1 includes drinking water regulatory limits for these constituents such as State of California and federal primary and secondary MCLs, State of California public health goals (PHGs) and action levels (ALs), California Proposition 65 values, and water quality limits established by the California Toxics Rule (CTR), which would be applicable to surface water discharge. Some ARARs (such as the California Ocean Plan requirements, National Salt Water Ambient Water Quality recommendations, and agricultural requirements) are not included in Appendix A as they are not relevant to the conditions at OU-2, or to reclaimed water. The human health standards of the CTR are not applicable, since a court case was recently resolved that determined that CTR criteria are not applicable to surface water reaches with a beneficial use designated as potential municipal.

The compounds listed in Table A-1 include selected constituents regulated for drinking water that are relevant to the Omega site. Future investigations at Omega, namely the planned investigation of potential source areas other than the former Omega Chemical Corporation site, may need to include analyses for other compounds identified as potential contaminants. Based on the results of a records search currently being performed by EPA, the list of analytes will be revised for the source investigation to include the additional compounds.

The *Water Quality Control Plan, Los Angeles Region* (LARWQCB, 1994) (Basin Plan) requires reuse of treated groundwater. The site remedy for groundwater will need to include treatment that meets drinking water standards, because of the potential for the use of treated groundwater for reclaimed water, surface water discharge, and groundwater recharge beneficial use. Depending on the outcome of the FS, the entire suite of analytes required by drinking water regulations may be included in later phases.

Additional standards that apply for the protection of fresh water aquatic life are considered for the FS phase of this investigation because discharge of treated groundwater to storm drains or other conduits will likely be considered. No surface water bodies are present at OU-2. Regulatory requirements applicable to these discharge methods were reviewed to determine which constituents require analysis and the necessary detection limits for each of the analytes or analyses.

The information in Table A-1 was used to determine appropriate analytical methods and required laboratory detection limits to meet the regulatory requirements. Low quantitation limits necessary to confirm compliance with these regulatory requirements may in some cases require the use of a non-contract laboratory program (CLP) laboratory.

3.2.3 Number and Location of Samples

The existing and planned monitoring wells will be sampled quarterly for 2 years. A summary of the location and number of groundwater samples per sampling event, without QC samples, is as follows:

- Proposed EPA monitoring wells PMW12 to PMW22 = 15 samples each quarter
- Existing EPA monitoring wells MW1 to MW11 = 18 samples each quarter

- Existing OPOG monitoring wells OW1 to OW8 = 10 samples semi-annually (to supplement OPOG's semiannual sampling)

A total of 359 groundwater samples, without QC samples, are anticipated for the duration of the 2-year sampling effort.

In addition to groundwater samples, field quality assurance (QA) samples will be collected in the form of duplicates, blanks, and MS/MSD samples. At a minimum, one field duplicate will be collected for each analysis for every 10 wells/screens sampled or one per week, whichever is larger. An attempt will be made to collect duplicate samples from a well that is expected, or known to be, moderately contaminated.

Equipment blank samples will be collected to check for possible cross-contamination of groundwater samples after decontamination of common equipment used to collect samples from a number of different wells or screens in a given day. The number of equipment blanks will be 10 percent of the number of primary samples. One equipment blank will be collected for every 10 field samples (thus, two blanks would be collected for a batch of 15 samples). The blanks will be collected for sampling of OU-1 wells; these wells will be sampled using a portable pump that will be decontaminated between wells. Because OU-2 wells have dedicated pumps, equipment blanks will not be collected during OU-2 sampling.

Field blank and trip blank samples will be collected to check for possible cross-contamination of groundwater samples by VOCs from the point of sample collection to analysis of the samples by the laboratory. Field blanks will be collected at a rate of 10 percent of the primary samples (one blank for every 10 samples). Trip blanks will be collected only if VOCs are found in the equipment or field blank samples. Analyses for BOD, COD, and alkalinity do not require blanks.

Laboratory QC samples (MS/MSDs) will be identified for all analyses during each sampling event. One MS/MSD sample per analyte will be identified for every 20 primary samples collected. A double volume of sample is collected for each MS/MSD. Temperature blanks will be used to determine that the samples have been maintained at the appropriate temperature of 4 degrees Celsius (°C). Temperature blanks will be prepared each day samples are collected and will be included with each cooler of samples sent to the lab.

3.2.4 Laboratory Analysis

Unless otherwise noted, laboratory analyses will be performed by EPA's Region IX laboratory. In some instances (such as short sample holding times or unique analytical method requirements), a laboratory other than EPA's Region IX laboratory may be used. Groundwater samples will be analyzed by using the methods described below.

3.3 Investigation Derived Waste

Liquid and solid IDW will be generated during drilling, development, and sampling of the proposed monitoring wells. Each of these wastes may potentially be contaminated with VOCs. Samples of the drill cuttings, drilling fluids, and development water will be collected from their storage units prior to removal from the site to evaluate the proper storage,

disposal, or discharge of the waste materials. The following subsections describe each of the wastes and the sampling procedures that will be used to characterize the wastes.

3.3.1 Drill Cuttings and Fluids

Drill cuttings and fluids will be generated during drilling of the monitoring wells. The drill cuttings will be contained in roll-off bins stored at each well site. Two grab samples will be collected for every 50 cubic yards of drill cuttings. Samples will be collected from bins that contain cuttings representative of the dominant soil material encountered during drilling. In the past, attempts have been made to use photoionization detector (PID) organic vapor reading to select cuttings for analysis. However, based on previous experience in the Whittier Narrows OU and Puente Valley OU, no organic vapors have been detected during monitoring of drill cuttings during drilling and logging of the cuttings. Thus, PID organic vapor monitoring or readings are unlikely to be useful for screening cuttings for sample collection.

Drilling fluids (water and mud) will be containerized in tanks and stored onsite at each well location. *One sample of drilling fluid will be collected per tank. It is likely that the drilling fluid in each tank will be fairly homogeneous as a result of recirculation, mixing, and agitation during the drilling process. Thus, one sample per tank should be sufficient to characterize the fluids in the tank. Because drilling mud tends to separate into the heavier mud at the bottom and lighter water near the top of the tank, the sampling bailer will be lowered near the bottom of the baker tank to collect a fluid sample with a high solids content.*

The drill cuttings and fluids will be analyzed for the following, according to local landfill requirements:

- pH
- Flashpoint
- Total Petroleum Hydrocarbons – Gasoline (TPHg)
- Total Petroleum Hydrocarbons – Diesel (TPHd)
- VOCs
- Total Threshold Limit Concentration (TTLC) Metals

The analyses listed above have been performed on wastes generated previously during well installation activities associated with VOC contamination in the Whittier Narrows and South El Monte OUs and none of the wastes have been classified as hazardous. A quick turnaround time (7 days) will be necessary for characterization and disposal of the drill cuttings and fluids to avoid costs associated with long-term storage of the wastes.

3.3.2 Development and Purge Water

During development and sampling of the wells, water will be generated that has the potential to be contaminated. Water generated from well development and sampling activities will be contained in tanks and stored temporarily at a central location onsite. One ground-water sample per tank will be collected. It is likely that the water in each tank will be fairly homogeneous as a result of mixing and agitation during the tank filling. Thus, one sample per tank should be sufficient to characterize the water. When collecting the sample from a

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tank, the sampling bailer will be lowered to the middle of the tank to avoid any water near the water surface that may have been affected by evaporation.

Well development and purge water samples will be analyzed for the following:

- VOCs
- SVOCs
- 1,2,3-Trichloropropane
- NDMA
- Perchlorate
- Nitrate
- 1,4-Dioxane
- Hexavalent Chromium
- Dissolved Metals

The rationale for the chemical analyses listed above is based on review of regulatory levels, as described in the companion QAPP, and evaluation of the parameters required to profile the liquid for treatment. A turnaround time of 7 days will be necessary to characterize and dispose of the development and purge water to avoid costs associated with long-term storage of the wastes.

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Figure
3-1 Proposed Groundwater Monitoring Well Locations

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SECTION 4

Request for Analyses

This section presents the request for analyses (RFA) and anticipated sampling schedule.

4.1 Analytical Parameters

Tables 4-1, 4-2, 4-3, and 4-4 summarize the analytical parameters and test methods for the samples that will be collected and submitted during the OU-2 quarterly groundwater sampling, discrete-depth sampling, waste water sampling, and waste soil sampling, respectively. The tables also indicate the sample preservation requirements, analytical holding times, sample container requirements, and the laboratory anticipated to perform the analysis. Unless otherwise noted, laboratory analyses will be performed by EPA's Region IX laboratory.

Target compound lists and reporting limits for all samples to be collected during this project (as approved by EPA) are included in Table A-1 (Appendix A). Standard turnaround times will be required for the quarterly groundwater sampling, 24-hour turnaround time will be required for the discrete-depth samples, and 5-day turnaround time will be required for IDW profiling samples. A mobile laboratory will be preferred for the analysis of the discrete-depth samples to accommodate the short turnaround time.

4.2 Schedule

The installation of the proposed wells and aquifer testing will proceed per EPA's direction. The start of this work is not anticipated before March 2004.

Groundwater sampling of existing wells will be conducted in February 2004 and subsequently on a quarterly basis. Groundwater sampling of the proposed wells will commence after they are constructed and will continue quarterly for a period of 2 years. Existing EPA and OPOG monitoring wells will be sampled quarterly and semi-annually, respectively, for a period of 2 years.

Scheduling of future soil, soil gas, air, and groundwater sampling events will be coordinated with the EPA, OPOG, and CH2M HILL staff. It is anticipated that the soil gas and soil sampling activities will commence in 2004.

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Table
4-1 Request for Analyses
(tables are separate Excel files)

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Table 4-1 continuedt

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Table
4-2 Request for Analyses
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Table 4-2 continued

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Table
4-3 Request for Analyses
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Table
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SECTION 5

Field Methods and Procedures

This section of the FSP provides information on field activities associated with the OU-2 study area. Included in this section are methods and procedures for the following:

- Soil gas and soil sampling
- Monitoring well drilling and construction
- Groundwater sampling
- Aquifer testing
- Use of sample containers and preservatives
- Decontamination
- Containment and disposal of IDW
- Sample management and documentation
- QC sample collection

5.1 Monitoring Well Construction

5.1.1 Well Drilling

Monitoring wells constructed for the OU-2 investigation will either be drilled using the dual-tube percussion hammer (dual-tube) method, air-rotary/casing-hammer (ARCH) method, or the mud-rotary method. The shallow and intermediate monitoring wells will be drilled using the dual-tube or ARCH methods. Drilling mud may be used during construction of the deeper monitoring wells or where collapsing of the borehole is encountered during drilling of the shallow and intermediate wells. Each drilling method is briefly described below. The determination of which drilling method to use will be made based on the overall technical approach and cost of subcontractor bids. Before drilling, the presence of underground utilities will be verified by Underground Service Alert (USA). A geophysical contractor will be called to survey drilling locations for which USA does not provide service. In addition, each boring will be started with a hand-auger or an air-knife to a depth of at least 5 feet to uncover any unknown or undetected utilities.

5.1.1.1 Dual-tube Percussion Hammer Method

The dual-tube drilling tooling consists of two nested drive casings advanced by a percussion hammer. Compressed air is circulated down the annulus between the two drive casings and up within the central drive casing (reverse air circulation), bringing the drill cuttings to the surface. Drill cuttings are discharged into a cyclone separator. The advantage to this method is that the borehole remains sealed by the drive casing at all times, thus reducing the production of groundwater during drilling. Drilling mud is not required to keep the borehole open. The method of air circulation also reduces the potential for compressed air intrusion into the adjacent formation compared to direct air rotary. Therefore, this method is expected to result in more representative discrete groundwater samples.

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Discrete-depth groundwater samples will be collected with a disposable bailer from every permeable unit encountered or intervals of approximately every 10 feet, whichever is less. The samples will be used to construct a depth profile of relative VOC concentrations in groundwater that will be used to select the well screen depth interval. The data will be used to screen the depth range containing the highest relative VOC concentration, not to assess the actual VOC concentration. Potential effects on the aquifer immediately surrounding the borehole from intrusion of compressed air will be minimized by thorough development of each well, so that samples collected from the completed wells will provide accurate measurement of the local groundwater VOC concentrations. While the dual-tube method does have the potential to reduce the VOC concentrations in the in situ groundwater samples collected during drilling, the impacts are not anticipated to significantly affect decisions based on the data.

Because of sandier lithologic conditions in the Santa Fe Springs area at the southwestern end of the contaminant plume, the dual-tube drilling method may not be able to complete some or all of the borings, particularly the deeper borings, in this area. If the dual-tube drill rig cannot complete a boring because of problems with excessive groundwater production or heaving sands, the drilling will continue using mud-rotary drilling methods.

5.1.1.2 Air-Rotary Casing-Hammer Drilling

The ARCH method consists of a single drive casing advanced by a percussion hammer. Compressed air is circulated down the drill stem and up within the annular space between the drill stem and drive casing (direct air circulation). Drill cuttings are discharged into a cyclone separator. Drilling mud is not required to keep the borehole open. The borehole remains sealed by the drive casing during drilling. Discrete-depth groundwater samples can be collected using the same procedures as during dual-tube drilling. Potential effects on the groundwater around the borehole will be minimized by thorough well development. Overall, this drilling method is similar to the dual-tube method; the drilling speed is generally slower. However, the major advantage of the ARCH method is that the drill rig can be converted to mud-rotary drilling if flowing sands are encountered. Such conversion is not available for dual-tube rigs.

5.1.1.3 Mud-Rotary Drilling

Drilling mud may be used during construction of the deeper monitoring wells or where borehole instability is encountered during drilling of the shallow and intermediate wells. Typically, mud-rotary methods are implemented to minimize borehole collapse and to assist in evacuating drill cuttings from the boreholes. Drilling mud is expected to reduce the possibility of cross contamination between groundwater zones, because it continuously invades the formation along the borehole walls and forms a low-permeability mud cake.

Drilling mud will consist of bentonite and water. No other additives will be permitted in the mud unless approved by the site hydrogeologist and EPA remedial project manager (RPM). The viscosity and density of the drilling mud will be tested periodically and maintained within the limits specified by the site hydrogeologist or engineer. Drilling mud will be forced down the drill pipe and out through ports in the drill bit utilizing the minimum quantity of mud required to evacuate drill cuttings from the borehole.

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5.1.2 Well Testing

5.1.2.1 Lithologic Sampling

Borehole drill cuttings will be collected for lithologic logging every 10 feet or at changes in lithology. Samples will be collected, lithologically logged by the field hydrogeologist and screened for organic contaminants with a photoionization detector. Following completion of the borings, samples will be disposed of with the rest of the drill cuttings. Downhole soil samples will not be collected for laboratory analysis.

5.1.2.2 Discrete Groundwater Sampling

In situ, depth-profile samples will be collected during drilling. It is anticipated that the boring will be advanced approximately 50 feet into the saturated zone and samples taken about every 10 feet beginning at the water table (approximately 30 to 70 feet bgs). These sample depths are tentative; actual sample depths will be selected based on encountered lithology with the goal of sampling permeable (coarse grained) units. The total anticipated boring depth will be 150 feet bgs or less.

For planning purposes, it is assumed that 5 in situ groundwater samples will be collected at each well, for a total of 55 environmental field samples (not including duplicates, blanks, and QC samples). Samples will be analyzed for VOCs (the primary contaminants of concern), as discussed in Section 4. The sample results will need to be available in time for determining the well construction; an onsite mobile laboratory will be required.

In situ groundwater samples will be collected during drilling of the intermediate wells, beginning at the water table and extending every 10 to 20 feet to the total depth of the well. Additional samples may be collected at the discretion of the onsite geologist, with the intention to sample saturated sand horizons. For planning purposes, five groundwater samples are assumed for each well. Discrete-depth sampling is not anticipated during drilling of the extraction well (PEW1).

At each in situ groundwater sampling depth, the hole will be cleared of all drill cuttings, and all water in the hole will be evacuated by circulating compressed air. Air circulation will then be shut off to allow formation water to enter the drive casing. An in situ grab sample will be collected using a polyethylene bailer when the water level has recovered approximately 3 feet up within the drive casing. Disposable bailers will be used, so decontamination of the bailers is not required. A 100-pound-test monofilament fishing line will be attached to the bailer and used to lower and retrieve the bailer. A new piece of line will be used for each sample. The bailer will be lowered through the annulus between the nested drive casings, quickly pulled to the surface, and an adapter specifically designed for the delivery of VOC samples (low-flow device) will be used to transfer water from the bailer to prepreserved volatile organic analysis (VOA) vials.

Only these discrete groundwater samples will be collected using a bailer. It is not practical and it would be costly to build temporary wells to collect these screening samples using low-flow sampling techniques. The samples will not be filtered in the field to avoid the loss of volatile organic compounds (VOCs). The mobile laboratory analyzing the samples may or may not filter them; analysis of unfiltered samples will be acceptable.

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5.1.2.3 Geophysical Logging

Mud-rotary boreholes will be geophysically logged immediately upon completion of the pilot hole for each well. Results from the geophysical logging will help determine the casing depth and well screen interval. Geophysical logs to be performed will include electrical resistivity (long and short normal) and spontaneous potential. Additional logs such as caliper or natural gamma ray may be conducted if deemed necessary. Dual-tube or ARCH boreholes cannot be geophysically logged prior to well installation. Wells installed in boreholes drilled by these methods may be logged using the induction and natural gamma methods, if deemed necessary. For the induction logging to be meaningful, the wells would have to be constructed entirely using polyvinyl chloride (PVC).

5.1.3 Well Construction

All single-screen monitoring wells will be constructed using 4-inch-diameter, flush-threaded Schedule 80 PVC casing and 4-inch-diameter (slotted) well screen (Figure 5-1). Wells installed in areas of high concentrations of chlorinated hydrocarbons (approximately over 1,000 $\mu\text{g/L}$) may be installed with Schedule 80 PVC casing and Type 316 stainless steel, continuous wire-wrapped, 0.020-inch slot well screens. Wells in low concentration zones will be installed with slotted (0.02-inch) PVC screens. Well construction details are summarized in Table 5-1.

Well clusters will be constructed as multiple-completion wells with two to three casings (and screens) within a single borehole. The diameter of the casings and screens will be 2 inches. Figure 5-2 presents a typical multiple completion well diagram.

A 5-foot, Type 316 stainless steel or PVC, as appropriate, sediment trap with end cap will be installed below each screen. All monitoring well screens are anticipated to be 10 feet long; longer screens (15 or 20 feet) may need to be installed in thick permeable units. Centralizers will be used above and below the well screen and every 40 feet above the screen if the ARCH or mud-rotary methods are used. Centralizers will not be needed if the well is constructed by the dual-tube method, as the casing is centered by the inner drive tube during well constructions.

Extraction Well PEW1 will be installed with a 5-inch-diameter, Schedule 80 PVC casing, a 20-foot, 0.02- or 0.03-inch slot PVC or continuous stainless steel wire-wrap screen, and a 5-foot sediment trap.

The filter pack is anticipated to be No. 3 Monterey sand (or equivalent). A transition sand will be placed between the filter pack and the casing seal. The seal will be constructed using bentonite pellets or chips, which will be hydrated in place. The annular space above the seal will be filled with a cement-bentonite grout made with Portland cement and Aquaseal and/or Volclay grout (Aquaseal and Volclay are trade names for an inert, sodium bentonite). Bentonite seals will also be placed between the screen intervals of multiple-completion wells.

Surface completions for each well will include flush-mount, traffic-rated well vaults set in concrete. Locks will be installed on each well to prevent vandalism and unauthorized access.

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5.1.4 Well Development

Monitoring wells will be developed prior to groundwater sampling by bailing, surging, and pumping with a temporary high-capacity submersible pump. The development water will be contained and sampled for future treatment. The high-solids, turbid water removed from the well initially will be stored with the drilling fluids. Less turbid water removed during the later stages of the development will be stored in a separate container.

Well development will be performed after the grout used to construct the well has been allowed to set at least 48 hours. The extracted water pH, specific conductivity, turbidity, and temperature will be recorded during the development in a field logbook. Water clarity will be measured and recorded upon completion of the well development with a nephelometric turbidity unit (NTU) meter or equivalent. Development will continue until water quality parameters are stable.

The well development requirements are as follows:

- The suspended sediment content of the water is less than 0.75 milliliter per liter (mL/L), as measured in an Imhoff cone according to method E160.5.
- The water turbidity remains within a 10 NTU range for at least 30 minutes, and the water temperature, pH, and electrical conductivity (EC) have stabilized (temp = ± 1 degree C, pH = ± 0.1 units, and EC = $\pm 5\%$).
- No sediment shall remain in the bottom of the well.

All development equipment will be decontaminated prior to start. The development process will be purely mechanical (i.e., no chemical additives will be introduced into the well).

5.2 Land Surveying

Surveying activities will be conducted by a qualified surveying subcontractor licensed in the State of California. The following land surveying activities may be conducted at OU-2:

- Obtaining elevations of groundwater monitor wells, the extraction well, soil borings, and soil gas survey points to an accuracy of 0.01 foot, referenced to msl.
- Establishing the elevation reference point for wells at the north rim of the top of the inner PVC well casing, and a permanent mark designating the elevation point. The ground surface elevation for each well and boring will be established to an accuracy of 0.01 foot.
- The horizontal datum of reference will be the North American Datum of 1983, 1991 adjustment (NAD91). Coordinates will be reported in the California State Plane Coordinate System, North Zone, in U.S. survey feet. Horizontal control shall be established to 0.1 foot.
- The location of each well and sampling point will be tied into a permanent land monument (e.g., building corners).

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5.3 Groundwater Sample Collection

Groundwater samples will be collected from the existing and proposed EPA wells, existing OPOG wells, and the proposed extraction well. The following subsections describe sample collection procedures that will be used during the monitoring program described in this FSP. These procedures do not apply to the collection of the discrete groundwater samples during the well installation (Section 5.1.2.2).

5.3.1 OPOG Wells

OPOG currently samples the OU-1 wells semiannually by purging three casing and gravel pack volumes before collecting samples, using a submersible pump. A casing volume is calculated by multiplying the head of water in the casing (well depth minus depth-to-water) by the cross-sectional area of the casing (πr^2). Determination of a casing volume is based on measurements of the depth-to-water at the time of sampling using an electric sounder. During each purge, water quality parameters (pH, temperature, specific conductance, and turbidity) are monitored and recorded. All purge water is containerized and disposed at an offsite facility.

CH2M HILL will use the low-flow sampling method also for the OU-1 wells. Using the same sampling technique will provide for more consistent results from OU-1 and OU-2 wells. The sampling procedures will be the same as described in the next section for the OU-2 wells, with the exception that a portable pump will be used. The pump will be decontaminated between sampling of different wells using procedures described in Section 5.6.

5.3.2 EPA Wells

Existing and proposed EPA monitoring wells will be equipped with dedicated bladder pumps to allow sampling using low-flow sampling techniques. Low-flow groundwater sampling is the process of purging and sampling wells at low flow rates from within the well screen zone to minimize purging and improve sample quality. Low-flow groundwater sampling has the advantage of producing a representative groundwater sample with far less total well purge water than is obtained from conventional sampling of monitoring wells, in which three well volumes are purged prior to sampling. Samples collected by the low-flow sampling method have been shown to be more representative than samples collected by the three-well-volume purge method. Low-flow purging and sampling refers to the velocity with which water enters the pump intake, not necessarily to the flow rate of water discharged at the surface. Water-level drawdown provides the best indication of the stress imparted by a given flow rate for a given hydrological situation. The proper flow rate for each well will be based on the ability to establish a low-flow rate at an acceptable level of drawdown (0.2 to 0.3 foot), and with minimum fluctuations of that water level during pumping. To achieve this, the pump will be initially operated at the minimum flow capacity of the pump, then the flow rate will be gradually increased until some initial drawdown is observed. The flow rate will then be reduced slightly to achieve a stabilized purge rate for the well. It is anticipated that flow rates on the order of 0.1 to 0.5 liter per minute (L/min) will be achieved. However, the flow rate will not exceed 1.0 L/min in any case.

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Careful, continuous measurement of field parameters including pH, temperature, specific conductance, dissolved oxygen (DO), oxidation-reduction potential (ORP) will be used to assess when purged water has reached equilibrium. The time interval between readings will be dictated by the stabilized pumping rate for each well (typically between 1 and 3 minutes). An initial change in the measurements typically indicates that water is being drawn from a different source ("active" versus "stagnant" water). Stabilization of these parameters would indicate that the water is coming from a steady-state source (the formation immediately surrounding the well screen near the pump intake). Equilibrium conditions are sometimes achieved after extraction of less than 10 liters, with 4 to 8 liters being the average reported in published studies. Therefore, the volume of water removed by this method during purging will be considerably less than with conventional purging techniques.

Accurate measurement of the field parameters will require a flow-through cell or other means to ensure that the purge water is continuously monitored. Although the flow-through cell is the preferred method, an acceptable alternate method is placing the probes in a small bucket or beaker that continuously overflows, with the discharge tubing placed near the probes, and covering the beaker or bucket with clear plastic film (such as Saran Wrap®). Each well will be pumped until the measured field parameters (temperature, pH, turbidity, and EC) have stabilized within 10 percent over three successive readings prior to collecting samples.

5.3.3 Field Parameters Measurement

A conventional pH meter with a combination gel-filled electrode or equivalent will be used for field pH and temperature measurements (digital readout). A combination conductivity-temperature-salinity-ORP meter will be used for specific conductance and oxidation-reduction potential measurements. Turbidity measurements will be made with a digital readout turbidity meter (readout in nephelometric turbidity units [NTU]). Samples for field measurements will be collected in a beaker used solely for field parameter determinations. All probes will be thoroughly rinsed with distilled water prior to, and between, any measurements at each well.

When using the low-flow sampling technique, flow-through cells will be used to measure the field parameters. Low-flow rate purging, sampling, and field parameter measurement of this nature is often referred to as "micro-purge" sampling and results in quicker sampling, generation of less purge water, and more representative sampling results.

Equipment used to measure field parameters will be maintained and calibrated according to manufacturer's specifications. At a minimum, calibration will occur at the start of each day, and will be recorded in the field logbook along with the equipment serial number.

5.4 Aquifer Testing

The proposed aquifer testing program will include slug tests, pumping tests, and specific capacity tests.

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5.4.1 Slug Tests

Rising and falling head slug tests will be performed in new and existing EPA and OPOG monitoring wells to evaluate aquifer hydraulic conductivity in the vicinity of the well. Slug tests will be performed after groundwater sampling using solid PVC slugs with clean bailer rope. A pressure transducer attached to an electronic recording device, such as an In Situ Hermit, will be used to record changes in pressure associated with water level recovery. Tests will be repeated two times to verify reproducibility. If the test well response is extremely slow, one test may be conducted. Multiple tests using different initial displacement will be conducted at rapidly responding wells.

5.4.2 Constant Rate Pumping Tests

Aquifer tests will be conducted on the existing SFS#1 and the proposed extraction well PEW1. Each test will consist of an initial step-drawdown test to determine the optimal pumping rate for the full pumping test, and a 72-hour constant flow rate test to define the hydraulic properties of the aquifer. Based on the drawdown response in observation wells, the duration of the test at PEW1 may be shortened to minimize the amount of waste water. Such consideration is not required for the test at SFS#1 because a wellhead treatment system is in place.

Nearby monitoring wells will serve as observation points. Well cluster MW08ABCD will be monitored during the PEW1 test. Wells MW04, MW05, MW06, MW08ABCD, MW09AB, MW10, MW11, PMW16, and PMW17ABC will be monitored during the test on SFS#1.

Water levels in the pumping and observation wells and barometric pressure will be monitored using pressure transducers attached to data loggers. Water levels and barometric pressure will be monitored for at least 72 hours prior to pumping, during pumping, and at least 24 hours after pumping. Discharge rate will also be monitored and recorded continuously during the pumping tests.

Short-term constant-rate pumping tests will be conducted at two new well clusters near the leading edge of the contaminant plume. Tentatively, the tests will be conducted at PMW15 and PMW18. The test locations may be revised based on the investigation results. The tests will be conducted immediately after well development using a portable submersible pump and the development rig.

The test will be conducted consecutively on all three wells (anticipated) within the cluster. The test duration of 2 to 4 hours of pumping will be followed by complete recovery to pre-pumping conditions. A step-drawdown test may be conducted prior to the constant rate test to establish pump rates, if needed. Water levels in all wells of the cluster, as well as barometric pressure, will be monitored using a pressure transducer and data logger. The flowrate will be measured at least every 15 minutes. Water levels and barometric pressure will be monitored for 24 hours prior to the test and for 24 hours after the test.

The containment and disposal of the extracted groundwater is described in Section 5.7.2.

5.4.3 Specific Capacity Tests

As part of the well development, the wells will be pumped using a portable submersible pump. Depth to water and flowrate will be measured during the pumping to estimate the

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well specific capacity (sustainable flowrate at a given drawdown). The specific capacity provides an indirect indication of aquifer properties. When practical, time-drawdown data will also be collected and analyzed as pumping test data.

5.5 Sample Containers and Preservatives

Sample container requirements and preservation methods for each analysis are summarized in Table 4-1 (previously presented). Sample containers will be laboratory-provided or purchased with certificates of cleanliness from approved laboratory product suppliers.

5.5.1 Groundwater

Samples to be analyzed for VOCs will be collected in three 40-mL glass VOA vials. A sufficient amount of 1:1 hydrochloric acid (HCl) will be placed inside the vials to lower the sample pH to less than 2.

Samples will be tested to ensure that sufficient preservatives have been added (e.g., a test bottle or vial), and the test bottles will be filled and checked to determine if sufficient preservatives have been added using the following (or similar) steps:

- Add preservative to test sample vial.
- Fill with sample, cap, and invert to ensure mixing.
- Test the pH to determine if less than 2 is achieved; if so, add same amount of preservative to the actual sample vial and collect the sample; discard the test vial.
- Add more preservative and repeat until pH less than 2 is achieved.

Many laboratories provide pre-acidified VOA-sample vials and these will be used, if available from the laboratory. A field check of the amount of preservative contained in the pre-acidified VOA vials will be conducted similar to the approach described above to confirm that sufficient preservative has been provided. If the pre-acidified VOA vials do not contain enough preservative to achieve the proper pH (<2), additional preservative will be added to the vial and repeated until the proper pH is achieved. This additional amount of preservative will then be added to each sample container prior to collection of samples.

The vials will be filled so that no headspace is present after sample collection. Filled containers will be checked by inverting the vial and tapping to reveal any air bubbles. If air bubbles are present, containers will be emptied, re-acidified, and refilled. If, after several attempts at sample collection, air bubbles remain, the sample will be described in the field notebook as an "aerated sample."

VOA vials will be cooled to 4°C and stored away from sunlight prior to shipping by immediately placing the full sample bottle into an iced cooler. The maximum analytical holding time for VOCs will be 14 days.

Samples for **dissolved metals** analysis will be passed through a 0.45-micron filter immediately after collection. The samples will subsequently be preserved by addition of nitric acid to a pH less than 2. The pH paper should not be inserted into the bottle as the dyes used contain metals. Samples will be placed into 1-liter polyethylene bottles and

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cooled to 4°C. The maximum analytical holding time for dissolved metals will be 6 months. If the groundwater samples contain enough suspected solids that filtration in the field is slow enough to delay sampling, then the samples will be submitted unfiltered to the lab, and the lab will be asked to filter the samples immediately upon receipt.

Samples for **hexavalent chromium** will be placed in one 125-mililiter (mL) polyethylene bottle and chilled to 4°C. The analytical holding time for this method will be 24 hours.

Samples collected for **perchlorate** will be placed in one 250-mL polyethylene bottle or together with nitrate in one 250-ml polyethylene bottle and cooled to 4°C. The maximum analytical holding time will be 28 days for perchlorate.

Samples for **cyanide** will be placed in one 250-mL polyethylene bottle, preserved with sodium hydroxide (sample pH>12) and chilled to 4°C. The analytical holding time for this method will be 14 days.

Samples collected for **NDMA** will be placed in 1-liter amber glass bottles and cooled to 4°C. Two liters will be collected for this analysis, and the maximum analytical/contract holding time for NDMA will be 7 days prior to extraction and 40 days following extraction.

Samples for **1,4-dioxane** analysis will be collected in unpreserved 1-liter glass amber bottles and cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 7 days prior to extraction and 40 days following extraction.

Samples for **1,2,3-TCP** analysis will be collected in three 40-mL glass VOA vials acidified using HCl to lower the sample pH to less than 2. The VOC vials will be cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 14 days.

Samples for **SVOC** analysis will be collected in two unpreserved 1-liter glass amber bottles and cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 7 days prior to extraction and 40 days following extraction.

Samples for **nitrate and nitrite** analysis will be collected in unpreserved 0.5-liter polypropylene bottles and cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 48 hours.

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Samples for **TDS** analysis will be collected in unpreserved 100-ml polypropylene bottles and cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 7 days.

Samples for **alkalinity** analysis will be collected in unpreserved 100-ml polypropylene bottles and cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 14 days.

Samples for **ammonia and total phosphorus** analysis will be collected in 0.5-liter polypropylene bottles acidified using H₂SO₄ to lower the sample pH to less than 2. The samples will be cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 28 days.

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Samples for **BOD** analysis will be collected in unpreserved 0.5-liter polypropylene bottles and cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 48 hours.

Samples for **COD** analysis will be collected in unpreserved 0.5-liter polypropylene bottles and cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 28 days.

Samples for **TOC** analysis will be collected in unpreserved 0.25-liter polypropylene bottles acidified using HCl to lower the sample pH to less than 2. The samples will be cooled immediately after sampling to 4°C. The analytical holding time for this analysis is 28 days.

5.5.2 Investigation Derived Waste

Samples of **drill cuttings** from roll-off bins for VOC analysis will be collected using an Encore or equivalent sampling apparatus and container. The Encore (or equivalent) sampling apparatus will be provided by the laboratory, as will the hermetically sealed 25-gram sample containers. The sample container will be pushed into the cuttings approximately 6 inches below the previously exposed surface of the material in the roll-off bin. The exterior of the container will then be wiped with a clean towel to remove any solids and permit closure of the container. The container will be closed according to the manufacturer's instructions. Sample ID information will be filled out on the back of the re-closable (originally hermetically sealed) sample pouch, as well as on a removable sample tag. The maximum analytical holding time for VOCs will be 14 days.

Drill cutting samples for additional analyses will be collected in brass sleeves in a manner similar to the collection of samples in Encore sample containers. Samples for analysis of TTLC metals will be placed in a brass sleeve, capped with teflon tape and plastic caps, and cooled to 4°C. The maximum holding time for TTLC metals is 6 months (28 days for mercury).

Samples for analysis of TPH will be placed in brass sleeves, capped with teflon tape and plastic caps, and cooled to 4°C. The maximum holding time for TPH gasoline is 48 hours and for TPH diesel is 10 days (from collection) and 40 days (from extraction).

Samples for analysis of flashpoint and pH will be placed in a brass sleeve, capped with teflon tape and plastic caps, and cooled to 4°C. The maximum holding times for flashpoint is 28 days.

One **drilling fluid** sample per each water-holding tank will be collected and submitted for laboratory analysis. Each sample will be collected using a new, disposable polyethylene bailer and inert rope to fill the appropriate sample containers. After collecting drilling fluid from near the bottom of the temporary storage container, the liquid will be slowly poured from the bailer into the sample container to minimize agitation and to prevent overfilling of the container. High liquid-content drilling mud holding times are identical to drill cutting and low liquid-content holding times, except that the samples will be collected in two 1-liter amber glass bottles and cooled to 4°C.

Monitoring well development and **purge water** from each well will be stored onsite in temporary storage containers (tanks or drums) pending results from sampling. Each well

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development water sample will be collected using a new, disposable polyethylene bailer and inert rope to fill the appropriate sample containers (e.g., acidified, 40-mL glass vials for VOC analysis). After collecting water from mid-depth in the temporary storage container, the water will be slowly poured from the bailer into the sample containers to minimize agitation and to prevent overfilling of the containers. Sample container requirements and analytical holding times are described in Section 5.5.2.

5.6 Decontamination

Field equipment used during groundwater sampling and aquifer testing activities will be decontaminated using the following procedure:

- Wash with non-phosphate detergent
- Rinse with methanol (groundwater sampling equipment only)
- Rinse with deionized water
- Rinse with high-performance liquid chromatography (HPLC)-grade water (groundwater sampling equipment only)
- Air dry

When a mobile submersible pump is used to sample wells without dedicated pumps, the following procedure will be used to decontaminate the pump and discharge tubing between wells:

- Submerge the pump and full length of discharge tubing in a non-phosphate detergent bath.
- Operate the pump, while submerged, to circulate detergent through the pump mechanism and discharge tubing. The pump will be operated long enough to allow a minimum of five tubing volumes to pass through the pump and discharge tubing.
- Remove the pump and tubing from the detergent bath and pump any remaining detergent back into the detergent bath or to waste. Rinse the pump and tubing with methanol. Submerge the pump and the full length of discharge tubing in a potable water bath.
- Operate the pump, while submerged, to circulate potable water through the pump mechanism and discharge tubing, and flush out remaining detergent. The pump will be operated long enough to allow a minimum of five tubing volumes to pass through the pump and discharge tubing.
- Remove the pump and tubing from the potable water bath and pump any remaining rinse water back into the potable water bath or to waste. Submerge the pump and the full length of discharge tubing in a deionized water bath.
- Operate the pump, while submerged, to circulate deionized water through the pump mechanism and discharge tubing, and flush out remaining potable water. The pump

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will be operated long enough to allow a minimum of five tubing volumes to pass through the pump and discharge tubing.

- Remove the pump and tubing from the deionized water bath and pump any remaining deionized water back into the deionized water bath or to waste.

The detergent, potable water, and deionized water baths will be emptied as IDW water and replenished daily. In general, wells will be sampled in an order progressing from least VOC contamination to highest VOC contamination, to prevent cross-contamination of wells with minimal or undetectable VOC concentrations. As an alternative to the above decontamination procedure, new disposable discharge tubing may be used at each well, with the pump mechanism decontaminated by submersion and pumping within detergent, potable water, and deionized water baths, consecutively.

5.7 Containment and Disposal of IDW

The types of wastes that may be derived from the RI field activities include drill cuttings and drilling fluids from drilling activities, water from developing and purging monitoring wells before sampling, protective clothing, and trace amounts of decontamination rinsate.

5.7.1 Drill Cuttings and Drilling Fluids

Drill cuttings and drilling fluids will be sampled and analyzed to assess whether they are hazardous. To expedite disposal of wastes, a laboratory provided by EPA will provide quick turnaround of waste analyses results. If testing indicates that none of the quantified VOCs are above federal and state regulatory levels and that the pH, flashpoint, and TPH results are acceptable (i.e., the wastes are not corrosive or flammable and contain petroleum hydrocarbons below landfill limits), the cuttings and solidified drilling mud wastes will be classified as nonhazardous and disposed of at a local Class III landfill.

If, however, the drill cuttings are classified as hazardous waste, then the bins will be hauled to a hazardous waste disposal facility approved to receive Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) wastes. Free liquids may be removed from the drill cuttings by solidification at each well site. The solidification process would involve pumping all free liquids off the drill cuttings and allowing the drill cuttings to solidify through natural evaporation.

If nonhazardous, spent drilling mud will be disposed of at a local facility specializing in drilling mud disposal. Free liquids may be removed from the drilling mud by solidification at each well site. The solidification process would involve pumping all free liquids off the drill cuttings and allowing the drill cuttings to solidify through natural evaporation. Nonhazardous drilling mud may be sent to a recycler for use in plugging oil wells or to a landfill for use as landfill cover material. If, however, the drilling mud is classified as hazardous waste, the material may be hauled to a hazardous waste disposal facility approved to receive CERCLA wastes or to an approved recycling facility.

5.7.2 Extracted Water

Groundwater extracted during the well development and aquifer testing will be stored in tanks or drums onsite, depending on quantity. Low-flow sampling of monitoring wells will

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potentially produce small quantities of VOC-contaminated water. This water will be temporarily stored in 55-gallon drums, properly labeled, and transported to a central location at the site. An effort will be made to separate water containing VOCs only from water containing dioxane, perchlorate, NDMA, metals, cyanide, and hexavalent chromium.

A sample will be taken from each tank (a composite sample from drums) and sent to a laboratory for VOC analysis. If the well development water sample results show that the water contains sorbing organics (VOCs and SVOCs) only, and at concentrations exceeding regulatory levels, the water will be treated onsite with a portable GAC drum to remove VOCs prior to discharge to the ground surface (e.g., street gutter or storm drain catch basin). This treatment system will be evaluated by analyzing the effluent water from the GAC drum for VOCs on a quick turnaround time basis (24 to 72 hours). The water will be allowed to settle for a few days prior to sampling and GAC treatment to allow suspended solids to settle to the bottom of the tank.

Once the GAC drums are no longer needed or have reached saturation with respect to VOCs and no longer remove VOCs in the groundwater, they will be disposed of according to applicable local, state, and federal regulations. The GAC drum supplier will sample, analyze, and profile the GAC according to applicable local, state, and federal regulations, as stipulated in a prepaid agreement with the supplier.

Removal of 1,4-dioxane, perchlorate, NDMA, metals, cyanide, and hexavalent chromium from pumped groundwater is not anticipated to be practical onsite. These compounds are expected to be encountered at elevated levels in groundwater from several wells only. If these compounds are detected above regulatory levels (see the companion QAPP), the water will be transported to an approved treatment, storage, and disposal facility (TSDF).

5.7.3 Clothing

All drilling and sampling activities included in this plan are anticipated to be performed in modified Level "D" personal protective equipment. Disposable protective clothing generated during the performance of the work will be contained in Department of Transportation-approved 55-gallon drums (i.e., 17H). The drums will be sealed and labeled to indicate site name, drilling locations, and what is being stored. If the drill cuttings and drilling mud are determined to be nonhazardous, the protective clothing will be disposed of at a local Class III landfill. If, however, the drill cuttings and/or drilling mud are classified as hazardous waste, then the drums will be hauled to a hazardous waste disposal facility approved to receive CERCLA wastes.

5.8 Sample Management Procedures and Documentation

The following section discusses various sample management procedures that will be followed during the performance of field activities. Included in these sections are procedures for sample packaging and transportation, sample labeling, and sample documentation.

5.8.1 Sample Packaging and Shipment

The sample packaging and shipment procedures are outlined below.

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5.8.1.1 Preparation of Sample Coolers

The following steps will be used to prepare the sample coolers:

1. Remove all previous labels used on the cooler.
2. Seal all drain plugs with tape (inside and outside).
3. Place a cushioning layer of recyclable cornstarch popcorn or bubble wrap at the bottom of the cooler.
4. Line the cooler with a large plastic bag to contain samples.
5. Double-bag all ice in resealable plastic bags and seal.

5.8.1.2 Packing Samples in Coolers

The following steps will be used to pack the samples in coolers:

1. Place the chain-of-custody (COC) form in a resealable bag and tape to the underside of the cooler lid.
2. Make sure that all glass sample containers are packaged in bubble wrap, secured with clear mailing tape.
3. Place samples in an upright position in the cooler.
4. Place ice on top of and between the samples.
5. Fill the void space between samples with recyclable cornstarch popcorn, double-bagged ice, or bubble wrap.
6. Custody seal large plastic bag containing samples and packing material.

5.8.1.3 Closing and Shipping of Cooler

Coolers will be packed with packing material surrounding the bottles to prevent breakage during transport. Ice will be sealed in plastic bags to prevent melting ice from soaking the packing material. Sample documentation will be enclosed in sealed plastic bags taped to the underside of the cooler lid. Coolers will be secured with packing tape and custody seals as described in the steps below.

1. Tape the cooler lid with strapping tape, encircling the cooler several times.
2. Place COC seals on two sides of the lid (one in front and one on the side).
3. Place "This Side Up" arrows on the sides of the cooler.

The coolers will then be delivered to the appropriate laboratory by the sampling team or by overnight courier the day of sample collection. Each day's sample shipment will be reported to the Region IX Sample Coordination Center (RSCC) Coordinator. For Friday shipments, the RSCC must be contacted prior to 12:00 noon to coordinate with laboratories that will receive sample shipments on Saturday. Samples will only be shipped on Friday if the laboratory provides assurance that analytical holding times will not be exceeded.

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5.8.2 Sample Labeling

The following information will be written on each sample container label with a permanent marker and will be covered with clear plastic tape:

- Sample location number (if CLP sticker is used)
- Case number, if applicable
- Type of analysis requested
- Preservative used
- Date and time collected

Custody seals will be placed over the lids of each sample container. Custody seals on the VOA vials will be placed around the lid to prevent covering the septum.

Immediately following sample collection, the filled sample containers with completed labels will be sealed with custody seals, placed in plastic resealable bags, and placed in a cooler containing ice. VOA vials (three vials per sample) will be wrapped together in bubble wrap, secured with tape, and placed into labeled, plastic resealable bags. All other glass bottles will be bubble-wrapped, and placed into labeled plastic resealable bags.

An example sample identification (sample ID) with an explanation follows:

OC2-MW20A-W-0-54

OC2	Prefix "OC" stands for Omega Chemical and "2" designates the operable unit (1 or 2) the sampling was conducted for; this sampling effort is conducted entirely for OU2.
MW20A	The location (well name) where the sample was taken.
W	Sampled medium: W for water or groundwater, S for soil or drill cuttings, G for soil gas or air.
0	Designation of sample type: 0 – primary sample 1 – field duplicate 2 – field blank 3 – equipment blank (rinsate) 4 – trip blank 5 – MS/MSD 6 – regulatory split
54	Sequential number denoting the order in which the sample was collected.

The codes for gas samples and regulatory split samples are included in the explanation above because they may potentially be used under this work assignment. They are not, however, part of the current effort covered by this SAP.

The IDW sample IDs will be labeled similarly, e.g., OC2-IDW-W-0-55 for waste water, OC2-IDW-S-0-56 for waste soil (drill cuttings).

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5.8.3 Sample Documentation

5.8.3.1 Field Notebooks

Bound and numbered logbooks will be used to record all sampling information. Information in the logbooks will include, at a minimum, the following:

- Name and title of the recorder, and date and time of entry
- General description of weather conditions
- Personnel involved with the activities
- Photographic log, if appropriate
- Sampling location and description
- Location of duplicate and QC samples, date and time of collection, parameters to be analyzed, sample ID numbers, blank ID numbers, whether or not split samples were collected, and if so, for whom
- Condition of well being sampled
- Serial number and calibration of field instruments
- Record of parameter values obtained during purging
- Time of sampling
- Sample description
- Shipping addresses for laboratories
- Names of visitors, their associations, and purpose of visit
- Unusual activities such as departures from planned procedures
- References to important telephone calls

All logs will be completed, signed, and dated by the recorder. All information recorded in the logs will be written with waterproof ink. Corrections will be made by crossing out the error with a single horizontal line, initialing the correction, and entering the correct information. Crossed-out information must be readable.

5.8.3.2 Chain-of-Custody Forms

Chain-of-custody procedures will be used to maintain and document sample collection and possession. After sample packaging, the following one or more of the COC paperwork forms will be completed, as necessary, for the appropriate samples:

- Organic traffic report and chain-of-custody record
- Inorganic traffic report and chain-of-custody record
- EPA Region IX Chain-of-Custody Record
- Overnight shipping courier air bill

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Copies of the above forms will be filled out and distributed per instructions for sample shipping and documentation in Appendix B. Completed field QA/QC summary forms will be sent to the RSCC at EPA's Region IX QAO at the conclusion of each sampling event.

5.9 Quality Control Samples

The QC samples will be collected or prepared to assist in determining data reliability. These QC samples include field duplicates, field blanks, and laboratory QC samples (for MS and MSDs). The QC samples are normally collected from locations that are suspected to be of moderate contamination. The QC samples will be collected immediately following, and using the same procedures as, the collection of the target sample.

5.9.1 Equipment Blanks

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Equipment blanks are collected to verify that contamination is not introduced to samples through the repeated use of sampling equipment at different sample locations. One equipment blank per sampling event will be collected from a submersible pump used to sample OU-1 wells. These wells have dedicated pump tubing, but not dedicated pumps. The pump will be decontaminated using the procedures outlined in Section 5.6 and a rinse sample will be collected and analyzed for VOCs. Section 4 provides the number of equipment blanks expected during the scheduled events.

5.9.2 Field Duplicates

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The field duplicate is an independent sample collected as close as possible to the original sample from the same source and is used to document sampling precision. Field duplicates will be labeled and packaged in the same manner as other samples so that the laboratory cannot distinguish between samples and duplicates. Field duplicates will be collected by alternately filling sample and sample duplicate containers at a location of known or suspected contamination. Each duplicate will be taken using the same sampling and preservation method as other samples. An attempt will be made to collect duplicate samples from monitoring wells that are known or suspected of containing the chemicals that are being analyzed. Section 4 of this FSP presents the number of field duplicates expected to be collected during the scheduled sampling events.

5.9.3 Field Blanks

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The field blanks are collected to verify that contamination is not introduced to samples during collection, handling, or shipping of the samples. They will be prepared by pouring blank water directly into the sample bottles (true field blanks) or by pouring blank water over or through decontaminated sampling equipment (equipment blanks). Commercially prepared HPLC water will be used for organic analyses and reagent-grade deionized water for inorganic analyses using the same preservation methods and packaging and sealing procedures used during collection of groundwater samples. Field blanks will be prepared and labeled in the same manner as the field samples and sent "blind" to the laboratory. During groundwater sampling a field blank will be collected at the first sampling location each day. A blank sample will be submitted daily for VOCs analysis. Section 4 of this FSP presents the number of and type of blank samples expected to be collected during the scheduled sampling events.

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5.9.4 Laboratory QC Samples

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Laboratory QC samples will be collected to perform MS and MSD analyses. An MS is an aliquot of a sample spiked with a known concentration of target analytes and provides a measure of the method accuracy. The MSD is a laboratory split sample of the MS, and is used to determine the precision of the method.

Twice the normal water volume will be collected for laboratory QC samples. Laboratory QC samples will be labeled as such on sample bottles and paperwork. The MS/MSDs will be collected at the discretion of the field crew, at a frequency of one in every 20 consecutively collected samples or one per week, whichever is greater. Section 4 of this FSP presents the number of MS/MSDs expected during the scheduled sampling events.

5.9.5 Trip Blanks

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Trip blanks will be used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures. A trip blank consists of a VOC vial filled in the laboratory with HPLC-grade water, transported to the sampling site, handled like an environmental sample, and returned to the laboratory for analysis. Trip blanks are not opened in the field, are prepared only when VOC samples are collected, and analyzed only for VOCs. Collection of trip blanks is not expected during the scheduled events.

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5.9.6 Temperature Blanks

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Temperature blanks will be included with each cooler shipment containing samples (regardless of targeted analysis) sent to the laboratory. A temperature blank consists of a VOC sample vial filled in the field with de-ionized water, handled like an environmental sample, and returned to the laboratory for analysis. The temperature blank provides a means of verifying that samples have been maintained at the proper temperature (4 °C) following collection and during transport to the laboratory.

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Table
5-1 Proposed Monitoring Well Completion Details
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Table 5-1 continued

Figure
5-1 Typical Well Completion Diagram

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Figure
5-2 Typical Multiple Casing Well Completion Diagram

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SECTION 6

Health and Safety Plan

The Health and Safety Plan for the activities described in this FSP is provided in Appendix C. A hospital location map is provided as Figure 6-1.

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Figure
6-1 Hospital Map in Health and Safety Plan

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SECTION 7

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Appendix A
Target Compound Lists and Reporting Limits

Appendix B
Sample Shipping and Documentation
Instructions

Appendix C
Health and Safety Plan

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